Chemical Looping Combustion of coal using ilmenite in 50 kW plant: effect of internals in fuel reactor.

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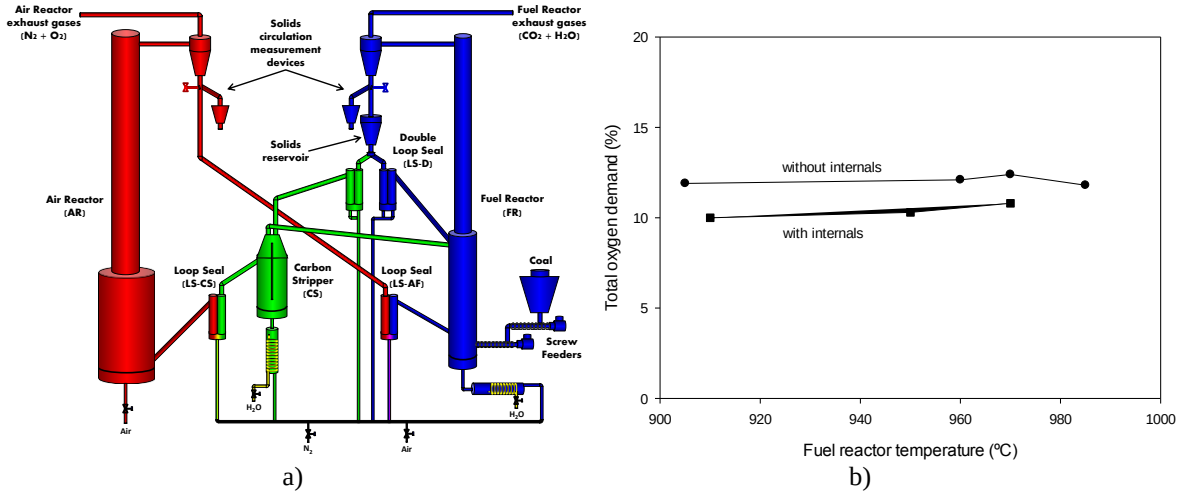
New technologies are being investigated to reduce the CO_2 emissions to the atmosphere by fossil fuel combustion. Chemical Looping Combustion (CLC) is a promising technology for CO_2 capture in power plants. Two fluidized bed reactors connected between them are used in CLC: fuel reactor (FR) and air reactor (AR). Metal oxides are used as oxygen carriers (OC), to transport oxygen from the air reactor to the fuel reactor. OC is reduced in FR in order to burn fuel, and is oxidized in AR with air. CLC could be used to burn gaseous, liquid or solid fuels. Coal is the most used fuel because it is a very abundant and has a low cost solid. However, for its use in CLC it is necessary the use of a Carbon Stripper (CS) downstream the FR. CS is used to increase coal residence time in FR by recirculating char to the FR again. Also, CS prevents char particles exiting the FR from going directly to the AR. Coal is directly fed in the fuel reactor and mixed with the oxygen carrier. Steam or recycled CO_2 are supplied to the fuel reactor as fluidizing agents.

A 50 kW CLC pilot unit consisting of two interconnected fluidized bed reactors (FR and AR) and a Carbon Stripper (CS) has been used to burn coal with CO2 capture and to investigate the effect the use of FR design modifications on the performance of iG-CLC process. Ring-type internals has been implemented along FR riser to enhance volatile matter conversion. These 3 internals were wedge-shaped designed, being the opening section the 60% of the reactor cross-section. Solid from the bottom part of the FR is held above each internal. The aim of the use of internals is to decrease oxygen demand, by improving the contact between OC and unburnt products from coal.

Two experimental test series were accomplished burning coal, i.e. without and with internals, to assess the effect of the presence of internals on the performance of the CLC unit. The CO_2 capture efficiency was scarcely affected by the presence of ring-type internals. Total oxygen demand is lower when internals were implemented. Comparison of these two experimental series is below. Total oxygen demand is reduced in a significant amount by the use of ring type internals insider the riser of the fuel reactor (FR).



a) b)

Fig. 1 a) Plant schematic layout of 50 kW pilot unit showing main parts; b) Effect of the use of internals in the riser of FR, on the variation of the oxygen demand with FR temperature.

References

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